MITRAL VALVE REPLACEMENT WITH PRESERVATION OF WHOLE MITRAL APPARATUS*

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Left ventricular (LV) function often deteriorates after mitral valve replacement. It has been postulated that disruption of the mitral valve apparatus at operation is a major mechanism of postoperative dysfunction. Between June 1991 and October 1992, 13 patients underwent MVR while preserving the mitral valve apparatus. 6 were female and 7 were male. The youngest 12 years old, the oldest 65 years old. The mean age was 29. Two of these patients were in NHYA Class II, 6 in Class III and 5 were in Class IV. Etiologic factors were rheumatic heart disease in 5, myxomatous degeneration causing mitral insuffiency in 6, and ischemic mitral insufficiency in 2 patients. Preoperatively and postoperatively echocardiographic studies showed left ventricular systolic dimension (LVSD) decreased by 11% (9-13), left ventricular diastolic dimension (LVDD) decreased 18%(10-22), left atrium dimension(LAD) decreased 15% (5-20). In our series one patient died on the 40th postoperative day because of after surgery cerebrovascular accident. 12 of surviving patients were followed-up 1 to 15 months with a mean of six months. We didn't detect any valvular dysfunction or any procedure - related symptoms in all of our cases.

Because of the difficulty of randomizing the patients retrospectively, in this study we haven't compared this group of patients with conventional MVR or with preservation of the posterior leaflet. However we have just tried to show both the feasibility of this method with no complications and surgical techniques of MVR with preservation mitral apparatus.

Key words: LV function, mitral valve appratus, MVR

Chordae-sparing mitral valve replacement (MVR) techniques may have advantage over conventional MVR with complete excision of the native mitral valve apparatus. Preservation of the chordae tendinea during MVR for mitral stenosis is often

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Table 1: Clinical data of 13 patients who underwent MVR.

No. of patients	13
Men: women	7:6
Mean age	29
Atrial fibrilation	7
NYHA functional class	
I	0
II	2
III	6
IV	5
Previous mitral valvotomy	1 (7.7%)
Previous Carpentier ring annuloplasty	1 (7.7%)
Predominant mitral lesion:	
Incompetance	8 (62%)
Stenosis	3 (23%)
Mixed	2 (15%)
Mitral valve pathology:	
Myxomatous	6 (46%)
Rheumatic	5 (39%)
Ischemic	2 (15%)
Concomitant diseases	
Tricuspid valve disease	2 (15%)
Aortic valve disease	2 (15%)
Coronary artery disease	2 (15%)
Left ventricular aneurysm	1 (7.7%)

difficult because the papillary muscle are bulky, hypertrophic and attached directly to thickened and sometimes calcified leaflet with complete disappearance of chordae tendinea.

Initially introduced by Lillehei and associates[1] in 1964 as a method of decreasing the prevalance of postoperative low-output syndrome, cordae sparing MVR did not gain wide acceptance.[2,3] Recently it has been proven that chordae preservation techniques has an important method of preserving left ventricular function after MVR[4,5]. Any previous studies have not attempted to compare posterior preservation of the entire mitral apparatus to outcome to functional results after MVR. However, the two preservation groups experienced similar, significant improvements.

We were able to show that is possible to perform MVR while preserving the mitral valve apparatus and this approach is feasible with both mono and bileaflet mechanical valves and bioprosthetic valves.

Materials and Methods

Between June 1991 and October 1992, 13 patients underwent MVR, while preserving the mitral valve apparatus. 6 were female and 7 were male. The youngest, was 12 years old, the oldest 65 years old. The mean age was 29±4.3. Seven of these patients had atrial fibrillation, while the other 6 had sinus rhythm. There was no change in their rhythm postoperatively. Two of these patients were in NHYA Class II, 6 in Class III and 5 were in Class IV.

Etiology in 5 patients was rheumatic heart disease, in 6 patients myxomatous

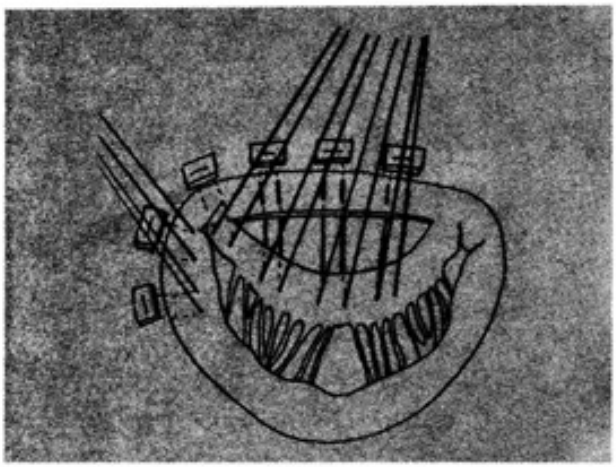


Figure 1 A

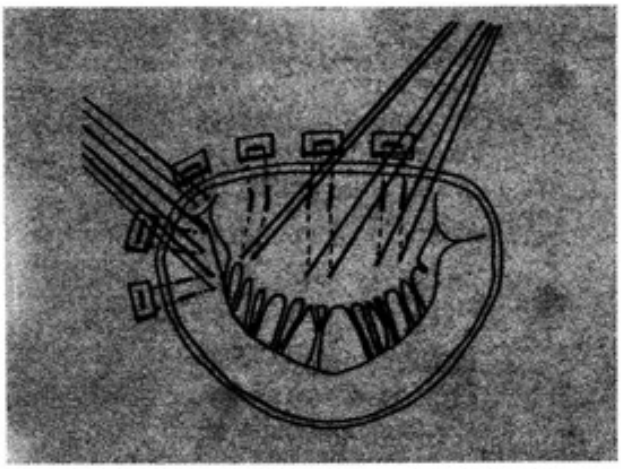


Figure 1 B

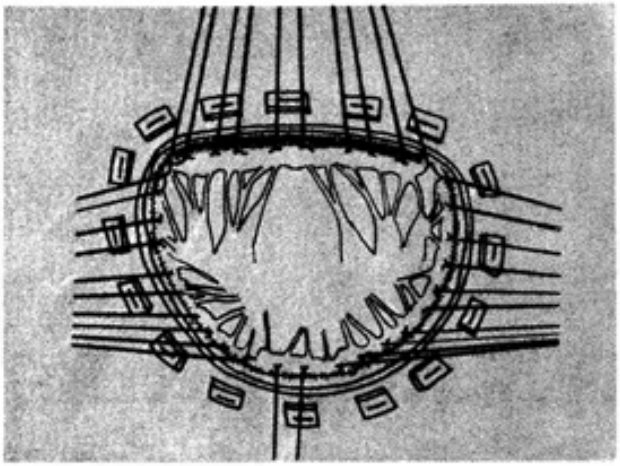


Figure 1 C

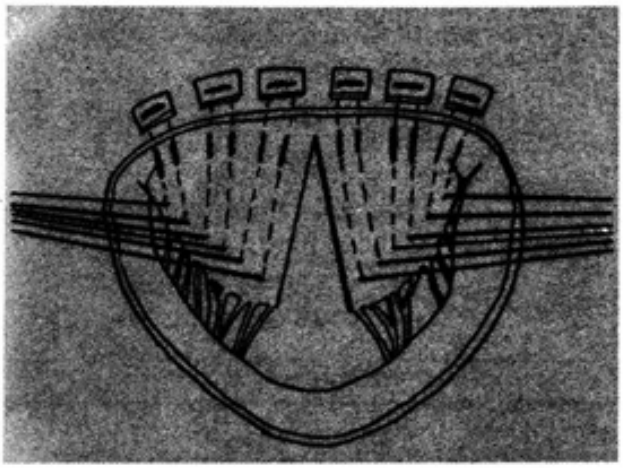
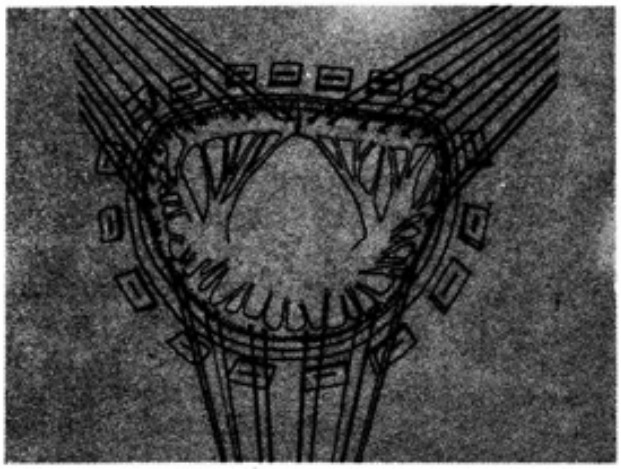


Figure 1 D



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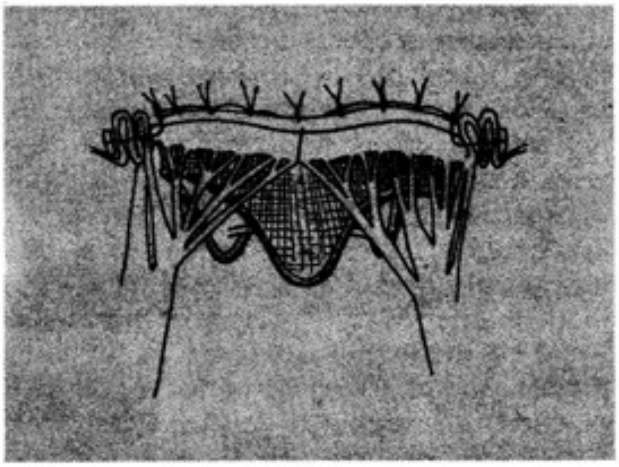

Figure 1 F

Figure 1. Surgical techniques of MVR with preservation of mitral apparatus.

Table 2: Distribution of surgical procedures.

Surgical intervention	Number of cases
MVR	8
AVR+MVR	1
MVR+Tricuspid annuloplasty	1
MVR+Aortic valvotomy+Tricuspid annuloplasty	1
MVR+CABG	1
MVR+CABG+İnferior aneurysmectomy	1

degeneration, and in 2 patients ischemic mitral insufficiency. Predominant mitral lesion was incompetence in 8 patients. In addition to mitral valve disease, 2 had tricuspid valve disease, 2 had aortic valve disease, 2 had coronary artery disease, one of them with a LVA (Table 1).

Operative technique:

All operations were performed with the patient under standart cardiopulmonary bypass, with a roller or centrifugal pump, membrane oxygenerator. Aortic and bicaval cannulation, left atrial venting, via left upper pulmonary vein was used. Fentanyl citrate and pancuroium were the routinely used anesthetic agents. Myocardial preservation was applied with systemic moderate hypotermia (26°C), and topical cooling (ice slush). St. Thomas II crystalloid cardioplegic solution was delivered after cross clamping the aorta, with intermittant application of cold blood cardioplegia through the aortic root with 20 minute intervals. Patients with severe aortic stenosis or aortic insuffiency received cardioplegic solution directly into the coronary ostia. Before reperfusion warm blood cardioplegia was also performed. Hemodilution was performed until hematocrit was 25%.

Operations performed and types of prostheses implanted are shown in tables II and III. Mean aortic crossclamp time was 76 minutes, in isolated MVR group mean cross clamp time was 61 min. Preservation of the whole mitral apparatus was not a cause for the useage of smaller valves sized.

We use three techniques for preserving the mitral valve apparatus:

First; In patients with myxomatous degeneration, where there is dilatation and weakening of the annulus, the valve apparatus is preserved totally. This also provides additional support for the weakened annulus. 2/0 polyester suture were initially passed through the annulus and then from the edge of the leaflet enabling plication of the apparatus in the subvalvular position. Then the suture was passed from the rim of the prosthetic valve (Figure 1A).

Second; In the situation where the anterior

Table 3: Type of valve used.

Valve size (mm)	Biocor	SJM	B-S
27	—	1	—
29	1	3	2
31	4	—	1
33	1	—	—
Total	6	4	3

leaflet was thickened, and was thought that plication will narrow the annulus, we resected the leaflet partially from its mid portion. After resection, the sutures were passed in the same manner as described above. This was done in the ischemic and some rheumatic cases (Figure 1 B-C).

Third; In this situation where the shortened chordae prevented annular plication of the leaflet, a wedge resection was performed in the median portion of the anterior leaflet, and plication was performed with chordae pulling towards the annulus. This approach prevents narrowing of the subvalvular area. (Figure 1 D-E-F).

Postoperative management and follow up: The range of follow up was from 1 to 15 months (mean six months). Na-warfarin combined with acetylsalisilic acid was given to patients with mechanical valve prosthesis after extubation(approximately postop. 12 th. hours), to patients with bioprosthesis and AF, giant left atrium, low cardiac output, intracardiac trombus and to patients with tromboembolic episodes.

Patients were followed on first, third and every fourth month postoperatively.

Control studies included history, ECG, and chest x-ray. Echocardiographic studies were performed on the first postoperative month and every fourth month thereafter.

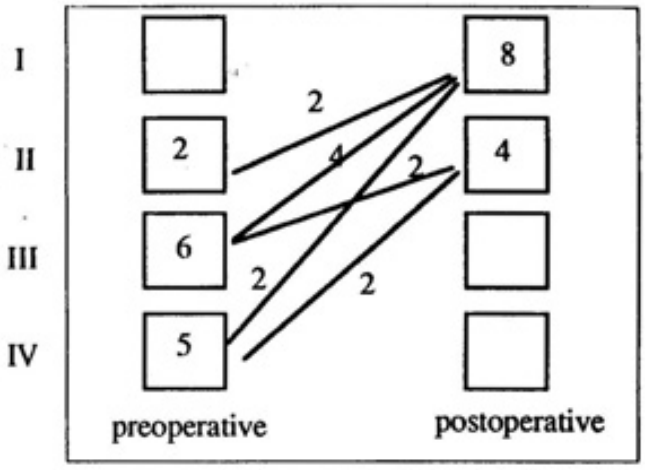

Figure 2 New York Heart Association functional class 6 months postoperatively.
*One patients died on the fourtieth postoperative day.

Results

In our series one patient died at the postoperative fourtieth day. This patient had MVR+ Aneurysmectomy+ Tripple aorto coronary bypass. This death was caused by a cerebrovascular accident, probably due to a hypertensive crisis. At his autopsy no cardiac cause was found, and the cardiac valve prosthesis was functioning normally.

Only in one patient we were able to detect echocardiograpygically a minimal narrowing in the LV outflow tract caused by obstruction of the subvalvular apparatus. However, even this patient was in NHYA Class I, and did not require any additional treatment. As a matter of fact, we didn't detect any valvular dysfunction nor any related symptoms in all of our cases (Figure 2).

In these patients chest x-rays showed marked dimunation in the cardiac sliuette postoperatively (Figure 3). In our patients pre and postop echocardiography showed LVSD decreased by 11% (9-13), LVDD decreased 18% (10-22), LAD decreased 15% (5-20). (Fig 4-5).

Discussion

It has been suggested that the continuity between mitral valve and LV wall through chordae tendinea and papillary muscle plays a role in LV function[6-8]. During the isometric period of the cardiac cycle, the contraction of the papillary muscles draws the closed mitral valve into the ventricular cavity, causing a shortening in the longitudinal axis and an increase in the short axis of the left ventricle. This allows the myocardial fibers to stretch additionally and consequently there is more tension, more contraction, and therefore, an increase in the stroke volume.

According to Thomas[9], papillary muscles

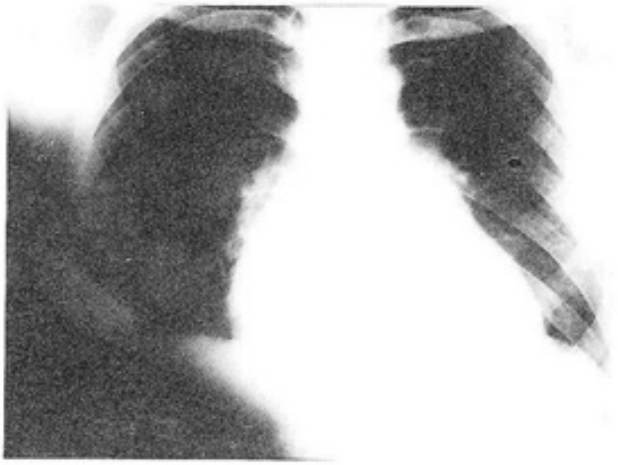

Figure 3 A

Figure 3 B

Figure 3 A-Preoperative chest x-ray and **B**-postoperative x-ray (R.K.-age: 28 male)

fascicles from three basic muscle layers (outer, middle, and inner) of the ventricular wall, with a fourth cylindrical layer (outside the inner layer) encompassing only the left ventricle. The anterolateral papillary muscle contains fascicles from all four LV layers. The posteromedial papillary muscle, in contrast, only contains fascicles from a portion of the outer layer and one land (of four) from the middle layer. It has been described that LV function deteriorates after resection of the mitral apparatus [1,4,5,10,11,13,14].

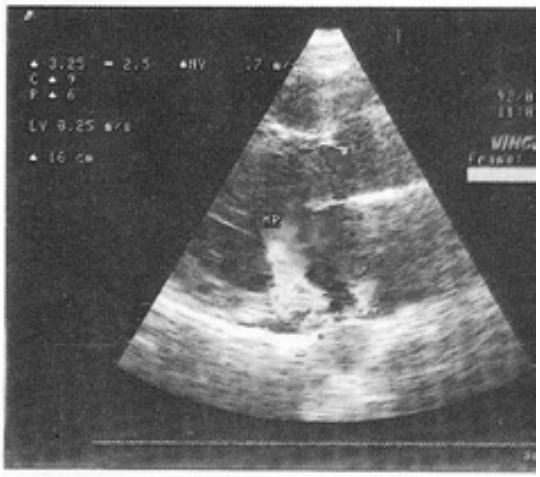

Figure 4 A

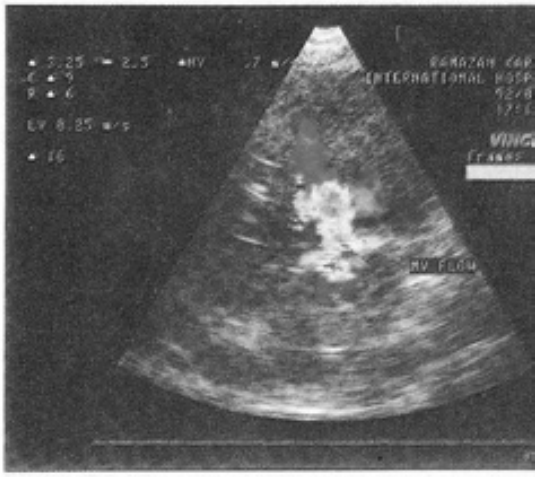

Figure 4 B

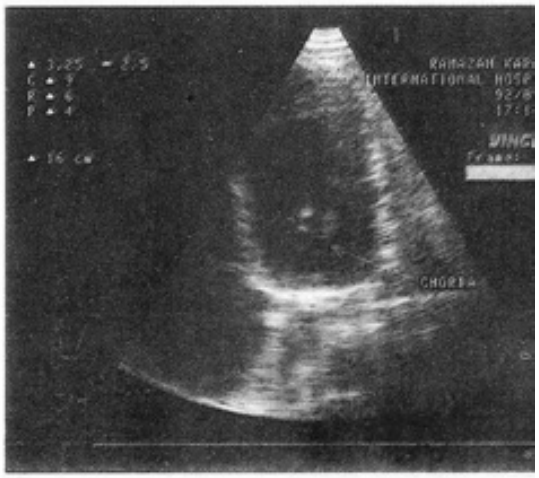

Figure 4 C

Figure 4 A Preoperative echocardiograhy and **B-C** postoperative echocardiography (R.K.-age: 28 male)

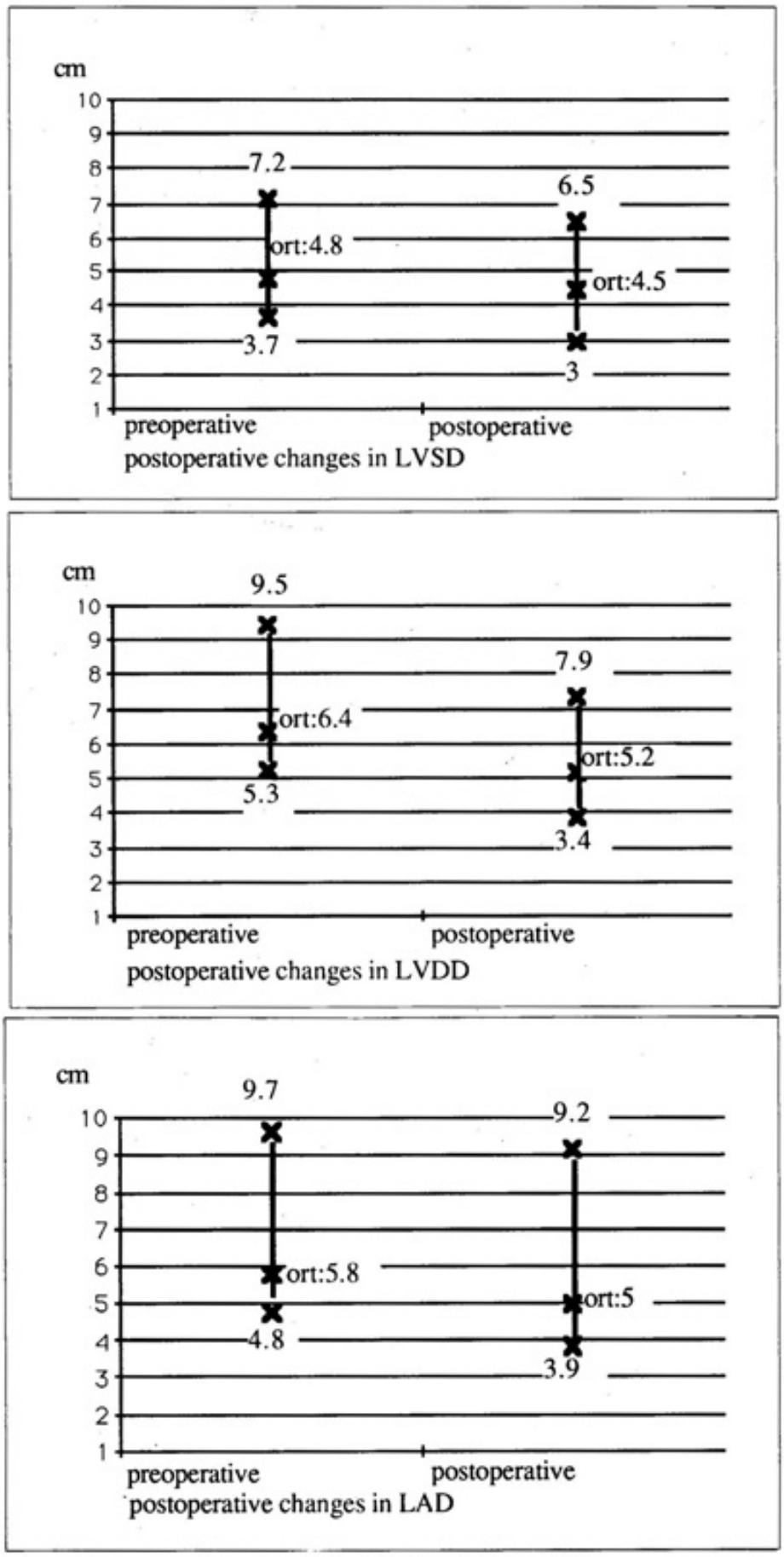

Figure 5. Postoperative changes in LVSD, LVDD, LAD.

The complex architecture, detachment of the papillary muscle, which constitute an active working portion of the ventricle, can effect contractility elsewhere in the ventricle, even distant from their insertion sites. On the other hand, it should be noted the posteromedial papillary muscle's contribution to global LV systolic function is not trivial, despite the dominance of anterolateral papillary muscle[9,10]. There are reports emphasizing the important of preserving the posterior leaflet [1,15]. However it has been reported that if the preservation of the posterior leaflet is insufficient and it is better to preserve the whole mitral apparatus[9,10,11,12,14]. Use of mechanical prosthetic valves is considered more risky regarding valvular dysfunction by some researchers. They recommed use of bioprosthetic valves[14,16]. However in our series we didn't counter any valvular dysfunction with mechanical valves.

Observations from experimental studies provide new insight into the potential mechanism responsible for valvular-ventricular interaction and offer further experimental favoring MVR using chordal-sparing techniques[10,11]. However, no comparative studies have yet been performed.

MVR with preservation of mitral apparatus decreases the operative risk of surgery and incidence of postoperative low cardiac output syndrome[1,12]

Left ventricular end diastolic pressure (LVEDP) decreased after correction of mitral regurgitation by valvuloplasty on valve replacement with preservation of chordae tendinea and papillary muscles and increased with preservation of chordae tendinea and papillary muscles and increased after conventional mitral replacement. The present study demonstrates that LVDD decreased significantly in all groups of patients. LVSD, however, decreased only in patients in whom the chordae were preserved, and did not change significantly in patients undergoing chordal excision.

Our observation in this group of patients was, when mitral valve apparatus is preserved, LV function recovery is faster compared to the conventional MVR. However, LV functional recovery is even faster in mitral valve reconstruction.

Because of difficulty of randomizing the patients retrospectively, in our paper we haven't compared this group of patients with conventional MVR or with preservation of posterior leaflet. Therefore, we are conducting a randomized prospective study comparing these groups. However, in this paper, we have just tried to show the feasibility of this method with no complications.

References

1- Lillehie CW: Levy MJ, Bonnobeau RC Jr: Mitral valve replacement with preservation of papillary muscles and chordae tendinea. J. Thorac Cardiovasc Surg. 1964; 47: 532-543.

2- Björk VO, Björk L, Malers E: Left ventricular function after resection of the papillary muscles in patients with total mitral valve replacement. J Thorac Cardiovasc surg. 1964; 48: 635-639.

3- Rastelli GC, Tsahirir AG, Fige RL, Kirklin JW: Exercise tolerance and hemodynamic studies after replacement of canine mitral valve with and without preservation of chordae tendinea. Circulation 1967; 35 (Pt 2): 134-138.

4- David TE, Uden DE, Strauss HD: The importance of the mitral apparatus in left ventricular function after correction of mitral regurgitation. Circulation 1983; 68 (Pt 2): II 76-81.

5- Hansen DE, Cahill PD, DeCampli WM, et al: Valvular-ventricular interaction: apparatus in canine left ventricular systolic performance. Circulation 1986; 73: 1310 - 1320.

6- Wiggers CS, Katz LM: Contour of the ventricular volume curves under different condition. Am. J. Physiol 1922; 58:439

7- Rushmer RF: Initial phase of ventricular systole:asynchronous contraction. Am J. Physiol 1956; 184:188

8- Rushmer RF: Finlayson BL, Nash AA: Movements of the mitral valve. Circ Res 1956; 4: 337.

9- Thomas CE: The muscular architecture of the ventricles of hog and dog hearts. Am J. Anat 1957; 101:17-580.

10- Kwok L Yun, MD, James I. Fann, MD- et al: Importance of the mitral subvalvular apparatus for left ventricular segmental systolic mechanics. Circulation (Suppl IV) Vol 82 No 5, November 1990.
11- David E. Hansen, MD, George E. Sarris MD, D. Crang Miller, MD et al: Physiologic role of the mitral apparatus in left ventricular regional mechanics, contraction synergy, and global systolic performance. J. Thorac Cardiovasc. Surg. 1989; 97: 521-533
12- Tirone E David MD: mitral valve replacemet with preservation of chordae tendinea. Saudi Heart Journal, Volume: No:3. October 1990
13- Hani A. Hennein MD, Julic A. Swain, MD. Charles L. Mc Intosh, MD et al: Comparative assesment of chordal preservation versus chordal resection during mitral valve replacement. J Thorac Cardiovasc Surg. 1990; 99: 828-837
14- Tirone E. David MD, Robert J Burns MD, C. Marra Bacchus et al: Mitral valve replacement for mitral regurgitation with and without preservation of chordae tendinea. J Thorac Cardiovasc. 1984; 88: 718 - 725
15 Taşdemir O, Katırcıoğlu F, Çatav Z., et al: Clinical results of mitral valve replacement with and without preservation of the posterior mitral valve leaflet and subvalvular apparatus. J Cardiovasc Surg 1991; 32: 509-515.
16- David H., Harpole Jr, MD, J. Scott Rankin, MD, Walter G Wolfe, MD, et al: Effects of standart mitral valve replacement on left ventricular function. Ann Thorac Surg 1990; 49: 866-74.